STABILITY OF A RECREATIONAL TRAVEL MODEL

MAY 1970 - NUMBER 11

BY

D. C. ROBINSON

JHRP

JOINT HIGHWAY RESEARCH PROJECT
PURDUE UNIVERSITY AND
INDIANA STATE HIGHWAY COMMISSION

Progress Report

STABILITY OF A RECREATIONAL TRAVEL MODEL

TO: J. F. McLaughlin, Director
Joint Highway Research Project

May 27, 1970

File No. 3-3-37

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

Project No. C-36-54KK

The attached report "Stability of a Recreational Travel Model" has been prepared by Mr. D. C. Robinson, Graduate Assistant in Research, on our staff, under the direction of Professor W. L. Grecco. The report is a Progress Report on the HPR, part II, research project "Recreational Impact of Federal Multi-Purpose Reservoirs".

The results of phase II of this research is included herein. The stability of the model developed in phase I to predict recreational trips to new reservoirs is evaluated in this report. In addition an estimate is made of the amount of gasoline consumed annually by motor boats for which the state fuel tax is paid.

The report is presented to the Board for acceptance as partial fulfillment of the objectives of the research project. It will also be forwarded to the ISHC and the BPR for review, comment and acceptance.

Respectfully submitted,

Harold L. Michael

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Associate Director

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STABILITY OF A RECREATIONAL TRAVEL MODEL

by

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Joint Highway Research Project
File No. 3-3-37
Project No. C-36-54KK

Prepared as Part of an Investigation

Conducted by
Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with the

Indiana State Highway Commission

and the

U. S. Department of Transportation
Federal Highway Administration
Bureau of Public Roads

The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the Bureau of Public Roads.

Not Released for Publication

Subject to Change

Not Reviewed By
Indiana State Highway Commission
or the
Bureau of Public Roads

Lafayette, Indiana
May 27, 1970

ACKNOWLEDGMENTS

The author wishes to express his sincere appreciation to Professor W. L. Grecco for his critical review of the manuscript, and for his guidance, advice and encouragement throughout this study; to the other members of his committee, Professor H. L. Michael and Professor V. L. Anderson, for their special counsel and comments; to Richard E. James for his assistance, guidance and advice in the statistical analysis section of this research; to Mr. Ron Woods for his guidance of the data collection; and to Mrs. Marian Sipes who typed the manuscript.

The author wishes to thank the Joint Highway Research Project of Purdue University and the Indiana State Highway Commission which, together with the support of the Bureau of Public Roads of the U. S. Department of Transportation, made this research possible.

The cooperation of the Indiana Department of Natural Resources and the personnel at each of the three reservoirs studied in this research was also greatly appreciated.

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ABSTRACT

Robinson, David Clifford, M.S., Purdue University, June 1970. Stability of a Recreational Travel Model. Major Professor: William L. Grecco.

This research reports the results of Phase II of a study to determine the recreational impact of multi-purpose reservoirs. The principle objective of Phase II was to evaluate the stability over time of a model developed in Phase I to predict recreational trips to new reservoirs in Indiana. The form of the model was $Y = A\ e^{-BX}$.

The New Reservoirs Model developed herein utilizes only road distance, county population and the influence of other similar facilities as the factors affecting attendance. A technique was developed illustrating how the model can be used to predict future attendance and traffic volumes.

Three parks, Raccoon State Recreation Area on Mansfield Reservoir, Lieber State Park on Cagles Mill Reservoir and Monroe State Park on Monroe Reservoir were used in the study. Data were collected (as in Phase I) by interviewing twenty-five percent of arriving trips at the park entrances. Almost 12,000 interviews were conducted over the period 1967 through 1969.

The New Reservoir Model was developed by non-linear regression analysis utilizing distance, population and the influence of other similar facilities. Two equations constituted the prediction model, one for the condition when there is no other similar facility closer to

a county than the reservoir under study, and one for the condition when there is another such facility closer to the county than the reservoir under study. A comparison was made between the two models developed in Phases I and II. It was found that while parameter B remained fairly constant over time, there was an increase in parameter A.

A secondary objective of this study was to estimate the total amount of gasoline consumed per year by motorboats in the State of Indiana for which state fuel tax was paid.

INTRODUCTION

In 1936, a national policy on flood control was established by the Congress of the United States. This policy provided: (i) that the Federal Government would cooperate with States and their political subdivisions on flood control projects; (ii) that flood problems would be tackled jointly by the U. S. Army Engineers and the Department of Agriculture; (iii) that project benefits must exceed project costs; and (iv) that projects recommended would not be constructed unless specifically authorized by law. Since 1936 more than 40 reservoirs have been constructed in the Ohio River Basin alone; 30 more are in the planning or construction stage.

Flood control, irrigation, and hydroelectric power were the three purposes originally considered in the benefit-cost analysis for justification of the construction of dams and their resulting reservoirs. There is, however, an added dividend of flood control dams that only in recent years has been recognized and included in the economic analysis. This dividend is the recreational lakes that are created by such dams.

Recreation is now recognized as an important business in this country. A substantial portion of the Gross National Product is devoted to recreational pursuits in all areas of the nation.

Traffic patterns have changed as the proportion of personal expenditure devoted for recreational purposes has increased. Many of

the rural highways serving recreational facilities may be properly classified as 'recreational highways'.

The development of the future highway network must take into account the traffic generating abilities of a recreational park or reservoir. A recreational facility is of little value without adequate access. Recreational highways exhibit such unique traffic patterns that it is not enough simply to use techniques that have been found valid for the analysis of traffic flows on urban streets and non-recreational rural highways. The usage of non-recreational highways is fairly uniform throughout the year, whereas recreational highways experience extreme peaking during the short vacation season, providing unused capacity throughout the rest of the year.

Water in one form or another is a necessary or desirable resource for almost all recreational activities. The multi-purpose reservoirs are therefore natural recreational attractions and consequently recreational traffic generators. It is essential for the full utilization of the recreational potential of a reservoir that transportation planning coincides with reservoir development plans. The best use of available resources of time and money can be made if the agencies responsible for planning have the means of determining demand prior to construction. Little factual information is available at present that can be used by planners to estimate the recreational demand. The best reservoir sites are generally found in areas with poor existing transportation facilities, where road design was for low rural traffic volumes. The traffic generated by the recreational facilities of a reservoir cannot be accommodated on roads such as these.

PURPOSE AND SCOPE

The area of water available for recreational purposes within the State of Indiana is in the process of being substantially increased under flood control programs of the U. S. Army Corps of Engineers. Six multi-purpose reservoirs have been completed to date; eight more are authorized and many more are planned (see Figure 1). The six completed reservoirs have added a total of over 20,000 acres of water at summer levels.

For multi-purpose recreation reservoirs, Federal funds are available for 100 percent of the flood control cost allocation and 50 percent of the additional costs for recreation and wildlife purposes, including land and minimum basic facilities. In Indiana, the State Department of Natural Resources is responsible for the development and operation of recreational facilities at such reservoirs.

It wasn't until 1967, when "Recreational Impact of Multi-Purpose Reservoirs" (1)* was published by the Joint Highway Research Project of Purdue University, that any information had been made available to the Indiana Department of Natural Resources for the planning of recreational facilities at reservoirs. Funding for the project was provided by the Bureau of Public Roads of the U. S. Department of Transportation and the Indiana State Highway Commission through the Joint Highway Research Project, Purdue University.

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*Numbers in parentheses refer to entries in the List of References.

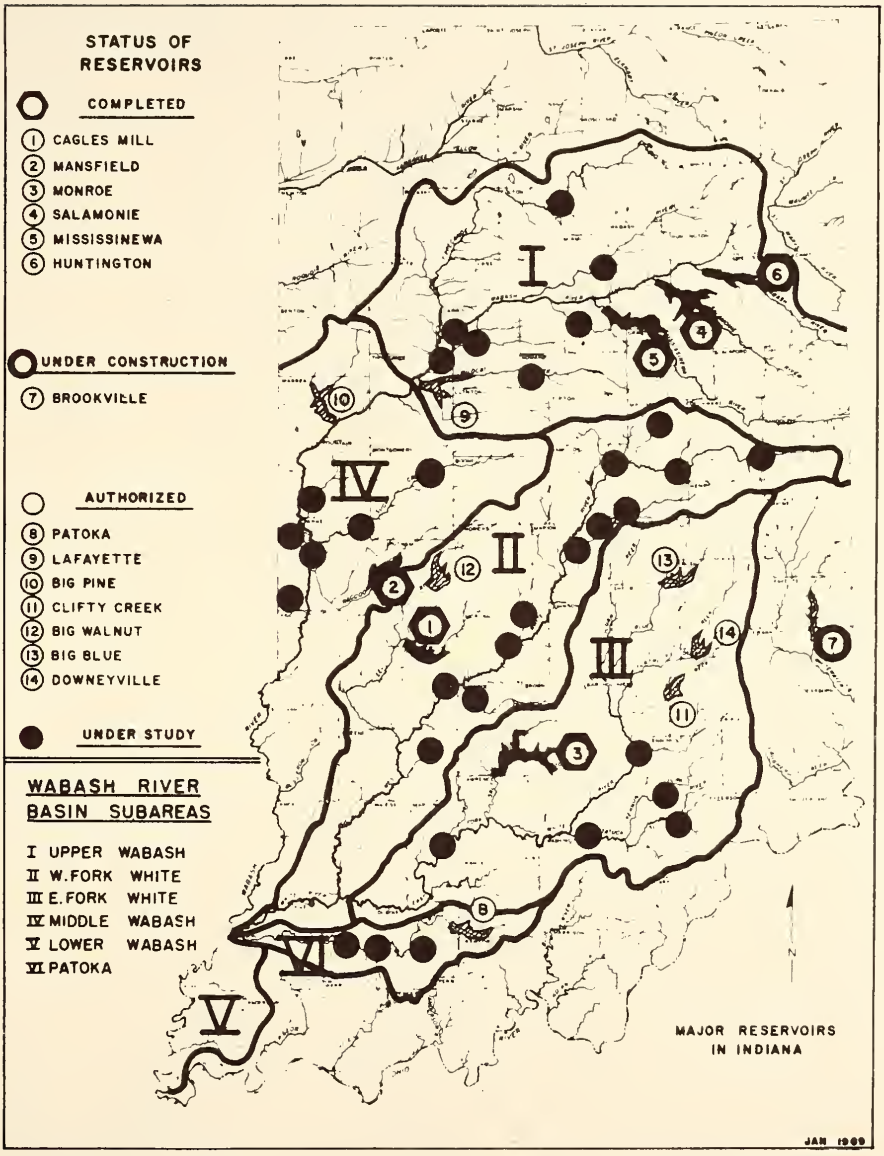

FIGURE I

MAJOR RESERVOIRS IN INDIANA

The result of the above research, in which Cagles Mill and Mansfield reservoirs were studied, was a model for the prediction of recreational trips to new reservoir areas in Indiana. The model utilizes road distance, county population, and the influence of other similar facilities as the parameters affecting attendance. The technique developed and described in the report illustrates how the model can be used to predict future attendance and traffic volumes to recreational areas at multi-purpose reservoirs.

In 1968, a proposal was submitted to the Joint Highway Research Board to continue this research into Phase II to include an evaluation of growth trends of recreational use, a study of motorboat fuel consumption, and further verification of the model developed in Phase I. The funding for Phase II of the research was from the same source as for Phase I.

During 1965 and 1966 under Phase I of the research, insufficient data were collected at Monroe Reservoir (which was then in the process of being developed) to be incorporated in the prediction model. However, by the end of Phase II of the research, all of the facilities shown in Figures 2, 3, and 4 were in operation at the three reservoirs.

The recreation facilities at each of the reservoirs are similar in type; however, the amount of facilities does vary between the three reservoirs. For example, Cagles Mill and Mansfield each have one beach several hundred feet in length; Monroe has three (one of which is operated by the U. S. Forest Service). Boat launching ramps are provided at various locations around each reservoir; five at Mansfield, two at Cagles Mill, and nine at Monroe. Within the main recreational

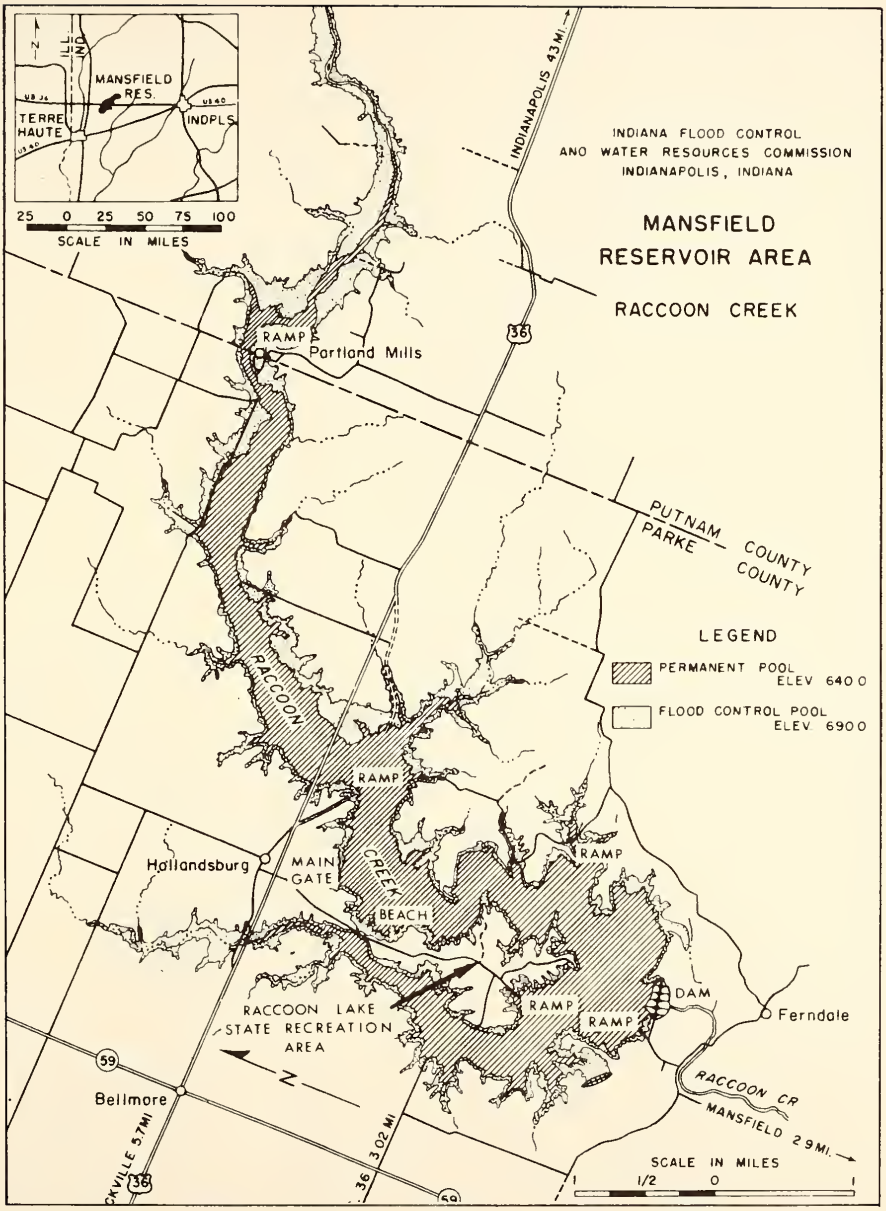

FIGURE 2

MANSFIELD RESERVOIR

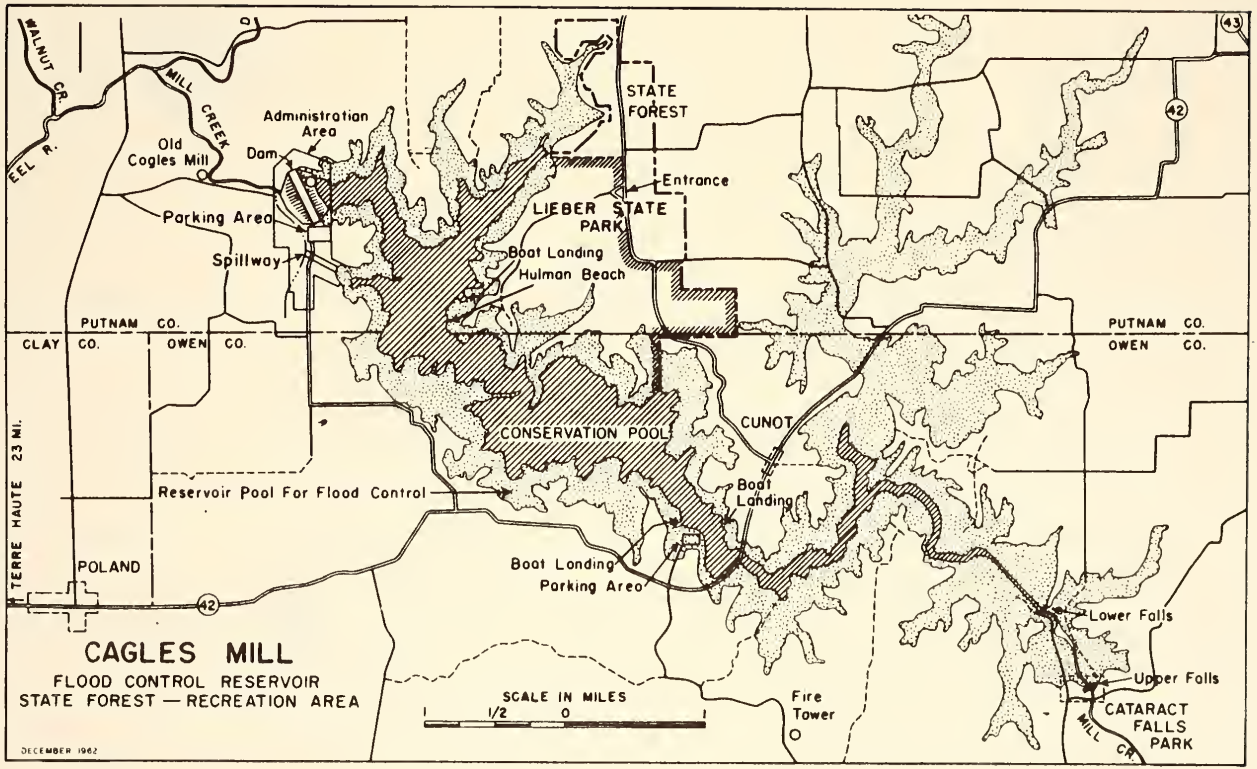

FIGURE 3

CAGLES MILL RESERVOIR

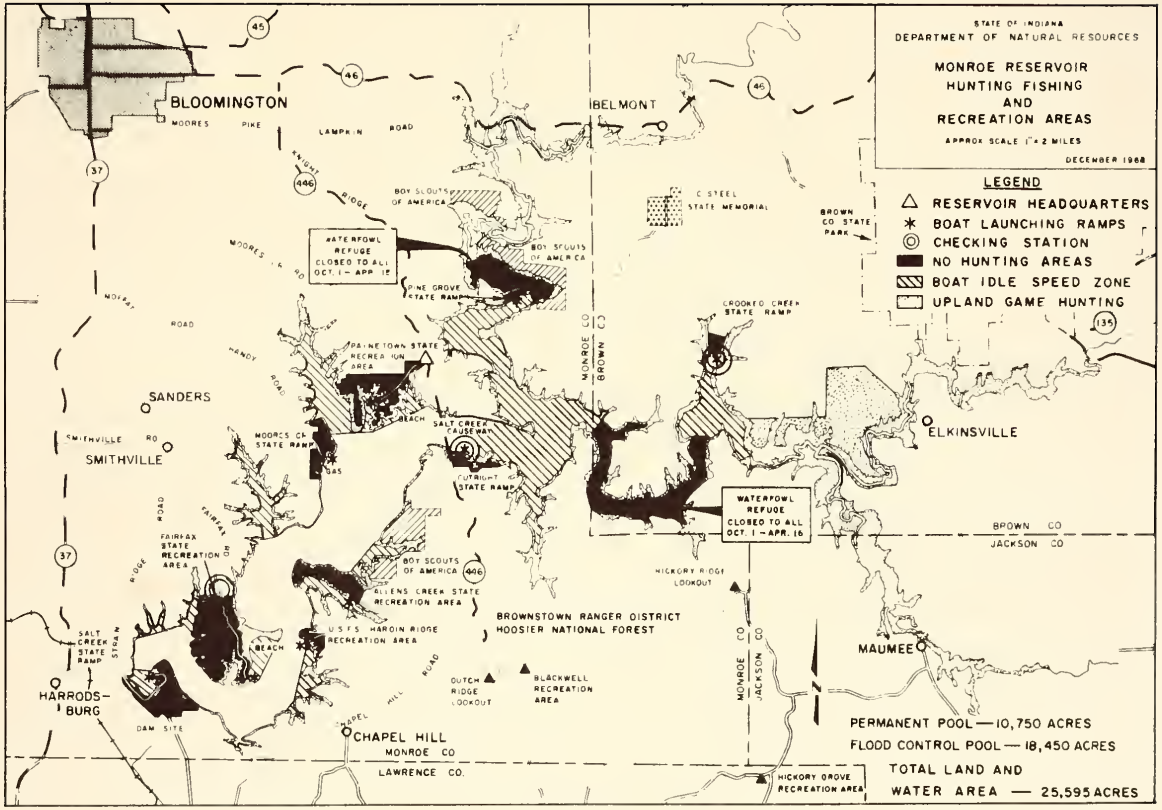

FIGURE 4

MONROE RESERVOIR

areas at each reservoir are located the camp grounds, beaches, concession stands, boat rentals, picnic areas, hiking trails and bathhouses. In general, each park is well kept by personnel who know and take pride in their work.

The need for outdoor recreational areas can only increase. In Indiana, recreational space and population are not well matched. Almost 70 percent of the general recreation land lies in areas south and west of Indianapolis with less than 25 percent of the total population (2). The use of flood control reservoirs for recreational purposes can provide a substantial portion of the needed public recreational areas, and every effort must be made to utilize such areas in the most efficient manner for the benefit of the public.

Proper utilization of these facilities requires an adequate highway system, ranging from local access roads to state highways. The main objective of this research was to provide a simplified method for estimating future traffic volumes for new facilities of this type.

RELATED WORK

Recreational Travel

In his report on Phase I of this research (1) Matthias reviewed several studies concerning techniques for analyzing and forecasting recreation travel. To avoid unnecessary duplication, only a brief review of these studies will appear here.

For the analysis of current demands for recreation, the series of reports published by the Outdoor Recreation Resources Review Commission (3) is an excellent source of information. The main report and its 27 study reports show the patterns of the demand for outdoor recreation in terms of type of recreation, age of population, economics and other factors. Locations of recreational resources, areas deficient in recreational facilities, and the relative popularity of the various recreational activities are also included. This information cannot, however, be easily converted into trip generation data.

Several reports, such as "The Automobile and Recreation" (4), and "Implications of Recreational Needs for Highway Improvement" (5) focused on the necessity for planning recreational facilities and the need for coordinated transportation and recreational planning.

There are only a few studies that have been aimed at the development of prediction models to facilitate the planning of new recreational facilities. Matthias reported on three such studies; the first, by Smith and Landman (6), who used both the gravity and

opportunity models to synthesize the existing county to recreational reservoir trip distribution in Kansas, and developed estimating equations for both reservoir and county trip ends using the multiple regression analysis technique; the second, by Schulman (7), who used a single exponent gravity model for the distribution of weekend recreational trips to parks in Indiana; and the third, by Ungar (8), who used an Activity Index, previously developed by Mueller and Gurin (9) which is based on a multiple classification analysis utilizing socio-economic and trip frequency data.

Each of the above three models assume, by the manner in which the regression analyses were performed, that park attendance is dependent upon the number or quantity of a park facility item (for example, Schulman used picnic tables). Matthias questioned this assumption, doubting that the exact number of picnic tables would cause any fluctuation in the attendance at large parks such as those found on Mansfield and Cagles Mill Reservoirs. The very existence of a suitable pleasant area for picnics would be more significant than the number of picnic tables. It is unlikely that visitors are aware of the number or quantity of any item.

One model not reviewed by Matthias is one which was developed under the Ontario Joint Highway Research Programme at the University of Waterloo, Ontario (10). Referred to as the "Ontario Model", it has been formulated using modern concepts of mathematical system theory, and is based on data from the 1964 Recreation Travel Survey (11). Further research (12) by the same author based on data from the 1966 Park User Survey (13) has resulted in considerable improvements over the subjective factors used earlier.

The system comprises three classes of components, each modeled in a different manner. The three classes are: (i) trip origins (a set of 54, centered upon the larger cities, towns and border points); (ii) highway segments (a set of 192 comprising of various Provincial Highways and other roads); and (iii) trip destinations (81 Provincial Parks). Each class of component is described by an appropriate equation, the parameters of which are determined individually for each component in the class. The equation for any particular component is not influenced at all by other components. The mutual influences and interactions of components are considered to be due only to the interconnection of the components, and not to their actual nature.

The model accounts for intervening opportunities by attaching an attraction index to each destination which is finely balanced with all other destination attraction indices. These attraction indices were used in an equation of the following form:

$$Y_p = A_p X_p \qquad (1)$$

where

A_p is the attraction index of park p;

Y_p is the seasonal camper usage of park p measured in camper days;

X_p is the pressure of camping demand as measured at the gate of park p.

Parks are considered to attract camping usage in direct proportion to their attractiveness for camping, all other factors being equal.

The highway links were modeled on a resistance basis. The form of this component equation is

$$Y_h = \frac{1}{R_h} X_h \qquad (2)$$

where

X_h is the demand pressure reduction from one end of highway link h to the other;

Y_h is the flow of camper-days along highway h;

R_h is the resistance of the highway to camper flow.

The resistance of each highway link was determined by the following formula:

$$R_h = \left(\frac{L_h}{S_h} + 0.67 \times 0.03 L_h\right)^{1.25}$$

where

L_h is the length of link h in miles;

S_h is the average speed over link h in miles per hour;

0.67 is a weighting constant;

0.03 is an average direct incremental cost of vehicle operation in dollars per mile;

1.25 is a constant exponent.

The origin area components were considered to act as sources of specified traffic flows, which were the numbers of camper days as observed in 1966 from the given origin areas. The form of their component equation was therefore taken as

$$Y_o = \text{known} \qquad (3)$$

Equations (1), (2) and (3) are combined by means of a linear graph method (14). The result is a set of simultaneous equations which can be solved for all pressures (propensity to camp) and flows (camper-days) in the system.

The author admits to not being completely satisfied with the overall predictive ability of the model in its present form. By this admission, the main objectives of the research have not been realized. There have been, however, side benefits from the research, in particular new knowledge on (i) how the recreational system of Ontario behaves, from empirical validation of the model in its various stages; (ii) how the interaction of one portion of the system with another may be predicted; and (iii) how the concept of attraction index for recreational destinations can be formalized into a technique useful for both analysis and planning.

As opposed to the Provincial Parks modeled by Ellis, Matthias considered a single type of recreational facility only, the state park located at a multi-purpose reservoir. All such parks in Indiana have, or will have, similar characteristics, although the amount of each type may vary depending on the amount of land available for recreational purposes. The parks will be situated on lakes of approximately 1000 acres or larger.

Matthias' prediction model was developed by using non-linear regression analysis to determine the parameters of distance, population and the influence of other parks. Two equations were developed, one for the condition where there is no other park closer to a county than the park under consideration, and the other for the condition where there is such an intervening park. Together the two equations constituted the prediction model.

Closest Park : $Y = 338\ e^{-0.579X}$

Intervening Park: $Y = 129\ e^{-0.488X}$

where

Y = annual trips per 1000 population from a county to a reservoir;

X = distance in tens of miles from a county to a reservoir.

A technique was developed illustrating the manner in which the model can be used to predict future attendance and traffic volumes.

Matthias observed that 80 percent of all trips interviewed at Mansfield and Cagles Mill (Monroe was not included in the model owing to insufficient data) originated from within 125 miles of the parks. Within an area 125 miles in radius it is likely that the proportions of the various socio-economic groups (from which the parks attract trips) are the same, with the result that these factors lose their significance. They should not affect the attendance at one park as opposed to the attendance at any other similar park within the same region.

Matthias' model is a method that can easily be understood by all concerned planning groups, since it utilizes only readily obtainable variables, such as road distance, county population and the influence of other similar facilities as the parameters affecting attendance.

Motorboat Gasoline Consumption

Recreational activities in general, and boating in particular, have increased tremendously in popularity since World War II. The estimated retail expenditures on boating rose from $905,000,000 in 1947

to $2,581,000,000 in 1963 (2). It is not known whether this figure includes sales of gasoline for motorboats; what is important, however, is the proportion that gasoline consumed by motorboats is of the total gasoline sales. In most states the price of gasoline includes a state tax which is designated for highway expenditures. Boating is a non-highway use of gasoline and thus it is possible to claim a tax refund.

Two of the studies involving motorboat gasoline consumption within the last few years are reported here. The first was performed in California in 1965 as part of a study of tax refunds for boats, aviation and agriculture (15), and the second was performed in 1967 in Missouri (16).

The California Study involved the questioning of nearly 53,000 registered owners of pleasure and commercial boats. Questionnaires were stratified by boat lengths within two regions of the state. Geographical stratification was based on the fact that gasoline consumption is higher in Northern California than in Southern California. The boat length stratification is based on the researchers' belief that length of boat constitutes the best single criterion of rate of gasoline usage, per boat, within a region. The study indicated that motorboats accounted for six tenths of one percent of the total amount of gasoline consumed within the State of California in 1964. It is estimated that only 14 percent of the total possible tax refunds were claimed.

A sample of 2,287 boats were included in the Missouri Study. Geographical stratification was greater than for California, there being 13 strata in all. The first seven strata consisted of metropolitan counties, the next four strata were counties considered to be lake

counties. The twelfth stratum consisted of six counties (each rural in character and having over five hundred registered boats) while the thirteenth consisted of eighty-three counties (rural, with less than five hundred registered boats.) This study indicated that motorboats consumed seven tenths of one percent of the total amount of gasoline consumed in the State of Missouri in 1966. No estimate was made of the refunded gasoline tax.

DATA COLLECTION

Data collection for this continuing study was carried out between June 1967 and August 1969 at each of the three parks. The primary source of data was a 25 percent interview of vehicular trips arriving at the parks. The 25 percent sample was chosen because it was considered adequate for analytical purposes and it did not create delays to arriving visitors.

With the exception of 1968, when reduced sampling was performed, interviewers were stationed both at gatehouses and boat ramps. At the gatehouses, the interviews were performed while arriving vehicles were stopped, either to pay fees or show a season pass. Each interview took approximately 20 seconds. At the boatramps the interviews were performed while the boats were being readied for launching.

Over the three year period interviews were performed at the following locations within each park:

Mansfield:	Main gate, Dam and Hollandsburg boat ramps.
Cagles Mill:	Main gate, Cunot Dock boat ramp.
Monroe:	Paynetown, Fairfax, and Hardin Ridge gatehouses, Cutright, Dam, and Moores Creek boat ramps.

It should be noted that Hardin Ridge (Monroe) has been developed by, and is under the administration of, the U. S. Forest Service. It is, nevertheless, a part of the recreational facilities offered at Monroe Reservoir and is, for this reason, included in the study.

The structure of the interviews was unchanged from that used in 1965 and 1966. It was decided that the interviewer should ask the driver from which county the trip had originated, as well as recording the license number, the prefix of which (on Indiana passenger cars) is a code number relating to the county in which the car was licensed. This was good training for the interviewers, since thereafter they did not fail to obtain the county of origin of vehicles for which the license plates have no such county code prefix (campers, buses, trucks, out of state vehicles).

The driver was asked the purpose of the visit. The number of adults and children (persons under 12 years of age) was determined. The number of adults and children was of greater importance prior to 1967, since the fee charged was dependent on the number of adults in each car. However, in 1967 the state introduced a fixed rate for each vehicle, and in 1968, an optional season pass was available.

The interviewers made note of any equipment carried, such as a boat, house trailer or camping trailer. The time of day, the date, park, interview location (main gate, or boat ramp) were also recorded. An example of a data collection sheet, and lists of Activity and Equipment Codes appear in Appendix A.

During the course of the interviewing, there were some samples that needed special consideration. Out-of-state cars were occasionally encountered (with differing frequencies at each of the parks). Drivers of such vehicles were asked if they were passing through or visiting in the area. Visitors to Illinois or Indiana were considered to be trips originating from the county visited.

Great care was exercised by the interviewers to avoid duplication of interviews; this was accomplished by locating the interviewer at the gate-house. Since the traffic volumes experienced at the boat ramps were much lower than those at the main gates, it was possible to ask if the vehicle had entered the park earlier.

All the interviews in 1967, 1968 and 1969 were conducted over the weekend periods, from Friday afternoon to Sunday afternoon during the months of June, July and August. Weekends were assigned at random. In 1967, each park was visited on 3 weekends. In 1968, Mansfield and Cagles Mill were each visited on 3 weekends and Monroe on 4 weekends. In 1969, each park was visited on 4 weekends.

The general procedure for weekends adopted in 1965 and 1966 was maintained during 1967, 1968 and 1969. Interviewing took place on Fridays from 2 p.m. until 9 p.m., Saturdays from 9 a.m. till 8 p.m. and Sundays from 9 a.m. till 5 p.m. These hours were selected on the basis of a pilot study made at Mansfield in 1965. After about 9 p.m. on Fridays and before 9 a.m. on any day of the week, few arrivals were noted. The parks were open 24 hours a day throughout the summer, but interviews were conducted only during the stated hours. The park records on attendance showed that on weekends the arrivals during the interview period usually accounted for about 90 percent of the total visitors on Saturdays and Sundays, and about 75 percent on Fridays.

During 1967 and 1968, two other sets of data were collected through interviews at each of the parks. Firstly, motorboat owners were interviewed at the boat ramps and asked questions concerning the horse-power rating of the boat engine, the average fuel consumption per

boating trip, the average annual usage of the boat and the main activity pursued. Secondly, drivers were asked to state the distance they had traveled to get to the parks and the time it had taken them to travel the reported distance.

Motorboat gasoline consumption data for 1968 were collected early in 1969 (17). A sample of 700 registered motorboat owners in the State of Indiana was randomly selected from lists maintained by the Department of Natural Resources. Each boat owner in the sample was mailed a questionnaire and a pre-paid return envelope. The questionnaire is shown in Appendix B. The returned questionnaires revealed information on the distribution of motors by horsepower rating, annual and daily boat usage, and annual and daily motor fuel consumption.

Preparation of Data

Over the three year period (1967 through 1969) 11,800 samples were collected by the interviewers and of this number, 11,400 were usable. The data obtained from the interviews were coded and entered on IBM cards, in such a way that one card represented one interview. The individual items of data from each interview, and the format in which they were entered onto each card, are listed in Table 1. The final step was to transfer the data from the cards onto magnetic tape for permanent storage with the interview data from Phase I of the study (1965 and 1966).

The summation program was used primarily to determine the number of trips to each park for each year from each county in Indiana and Illinois, as well as from other states. It was also possible to summarize any of the separate items of a sample in any desired manner.

TABLE I

INTERVIEW DATA ON IBM CARD

ITEM	COLUMN(S)	REMARKS
PARK	1	1 Mansfield 2 Cagles Mill 3 Monroe
LOCATION	3	1-5 Mansfield 1-2 Cagles Mill 1-9 Monroe
MONTH	5-6	1-12
DATE	8-9	
YEAR	11	3 1967 4 1968 5 1969
DAY OF WEEK	13	1-7 Sunday(1), Saturday (7)
WEATHER	15	1 Clear-hot 2 Cloudy ~ cool 3 Rain 4 Cloudy
SAMPLE PERCENTAGE	17	1 25 % 2 100 %
HOUR	19-20	1-24
COUNTY	22-23	
STATE	25-26	1 Indiana 2 Illinois 3 Ohio, ... etc
EQUIPMENT	28	1 Boat 2 House Trailer 3 Camping Trailer
PEOPLE	30-31	Total Number in Vehicle
CHILDREN	33-34	Under 12 years of age
BOATING	36	1, if activity stated, blank otherwise
CAMPING	37	
FISHING	38	
PICNICKING	39	
OTHER	40	
SWIMMING	41	
HIKING	42	
LOOKING	43	

It was not an unusual occurrence for visitors to report multiple purposes when asked the reason for visiting a particular reservoir. It is probable that most trips to a reservoir are made with more than one purpose in mind. However, in this study, only the purposes reported were recorded since these were considered as the purposes which inspired the trip. Also, no effort was made to determine if, in fact, the stated purposes were actually accomplished. The trip purposes considered were boating, camping, fishing, picnicking, hiking, swimming, looking, and others.

It was apparent, once county trip totals were determined, that over 90 percent of all trips originated from within 125 miles of a reservoir. Thus, for the purpose of this analysis, no counties beyond 125 miles of each reservoir were considered. The observed trips per county beyond this range were so sparse as to be insignificant.

In order to standardize the trip rate from any particular county, a unit of measure was required. The unit selected in Phase I of the study was trips per 1000 population; this was adhered to in Phase II. There is a large variation among county populations in Indiana. Marion County contains 830,000 people, while Union County contains only 6000. It is obvious that the total number of trips from the counties would vary even if their distances from a park were identical. The use of a trip rate tends to normalize the disparity of population differences.

The official attendance (vehicles) for each year at Mansfield and Cagles Mill was obtained from attendance records maintained by the Department of Natural Resources; Monroe attendance figures were obtained from the Park Superintendent, Monroe Reservoir and the U. S. Department of Agriculture Forest Service.

It was necessary to expand the official attendance figures since these were collected at the main entrances only, and thus did not include attendance at boat ramps. The official total attendance figure for each reservoir was divided by the appropriate Total Attendance Expansion Factor, which is the ratio of samples interviewed at boat ramps to samples interviewed at main entrances, from Table 2. It should be noted that in the case of Monroe, the expansion factors were applied only to the official attendance figures of the State Recreation Area; the attendance at Hardin Ridge (U. S. Forest Service) Recreation Area was included afterwards. The estimated total attendance (vehicles) at each reservoir for each year is shown in Table 3.

The observed trips from a county were divided by the appropriate County Trip Expansion Factor, which is the proportion of the estimated total trips to a park that were sampled in a year. County Trip Expansion Factors are listed in Table 4.

The Indiana county population estimates for 1967, 1968 and 1969 were linear interpolations of projections developed by the Indiana University, Graduate School of Business (18). The Illinois county population estimates were linear projections of 1960 census data and U. S. Bureau of Census estimates 1966 (19). The distance figures were developed from the center of each county to the center of each reservoir. Road miles were measured using the primary highway system.

It became apparent, when comparing Illinois and Indiana county trip rates for equivalent distances from a reservoir, that Illinois county trip rates were significantly lower. It was decided to add a stateline penalty equal to 30 miles to all Illinois counties. This has the effect

TABLE 2

TOTAL ATTENDANCE EXPANSION FACTORS

FACILITY	1967	1968	1969
CAGLES MILL	0.814	0.781	0.760
MANSFIELD	0.739	0.808	0.855
MONROE	0.915	0.897	0.870

TABLE 3

ESTIMATED TOTAL ATTENDANCE

FACILITY	1967	1968	1969
CAGLES MILL	42713	50570	43149
MANSFIELD	60486	63592	41477
MONROE	39269	77758	108646

TABLE 4

COUNTY TRIP EXPANSION FACTORS

FACILITY	1967	1968	1969
CAGLES MILL	0.015	0.012	0.022
MANSFIELD	0.018	0.014	0.030
MONROE	0.051	0.012	0.013

of including in the analysis only those Illinois counties within 95 miles of a reservoir.

The data from the motorboat gasoline consumption study were originally arranged into eleven categories of horsepower rating, ranging from 0.0 to 4.9, to 200.1 up. In two of these categories however (150.1 to 200.0, and 200.1 up) only one sample was recorded. It was therefore decided to combine the three highest categories into one, making a revised total of nine.

Fourteen percent of the returned questionnaires stated that a boat was no longer owned. A revised estimate for the total motorboat registration in Indiana (quoted as 155,000 by the Department of Natural Resources) was therefore calculated - this was found to be 133,169.

Since 25 percent of the motorboat owners in the sample admitted to owning more than one motor, the revised estimate for total motorboat registration calculated above was converted into a figure representing the total number of motors owned by Indiana motorboat owners. It was this figure (175,194) that was distributed among the nine horsepower rating categories.

ANALYSIS

Development of the Prediction Model

For each reservoir, a plot of the county trip rates (calculated from 1967, 1968, and 1969 data) versus distance from the reservoir indicated an exponential relationship. This supported Matthias' choice of an exponential model to describe the 1965 and 1966 data. It should be added that this result was not entirely unexpected since previous research (20) has shown an exponential relationship between trip length and distance.

The form of the function used by Matthias and subsequently in this research is

$$Y = A\, e^{-BX}$$

where

Y = annual trips per thousand of population from a county to a reservoir;

A = Y intercept of non-linear regression curve;

B = rate of change of non-linear regression curve;

X = distance in tens of miles from a county to a reservoir.

There are two approaches by which the parameters A and B in the above equation may be estimated. Firstly, it is possible to use the method of least squares after transforming the function into the form

$$\text{Ln } Y = \text{Ln } A - BX$$

Secondly, a non-linear regression analysis which estimates the parameters in an iterative manner may be applied. The first approach assumes the errors in the transformed function to be additive, which necessitates that the errors in the original be multiplicative (an assumption that has no physical basis). The second approach assumes additive errors in the original function and, since errors of an additive nature are more probable, this method was adopted. (An added benefit from using the second approach was only apparent later; this was when certain distant counties were found to have zero trip rates. A logarithmic transformation would not have been able to deal with this situation.)

The non-linear regression analysis utilized was NONLIN, a revised version of SHARE 3094 (21), and this was described in some detail by Matthias. Basically the program finds the estimates of the parameters A and B in the function $Y = Ae^{-BX} + \epsilon$ by minimizing

$$\sum \epsilon^2 = \sum (Y-\hat{Y})^2$$

where ϵ is the residual error, and $\hat{Y}$ is the estimate of Y. It is an iterative technique which requires an initial estimate of the two parameters, A and B.

Matthias (as mentioned in RELATED WORK) developed two regression equations which together constituted the prediction model. One equation was to be used for counties that are closest to the specified reservoir, and the other for counties that are closer to one or more other reservoirs than to the specified reservoir. These equations were developed, however, with data from Mansfield and Cagles Mill only, since insufficient data were collected from Monroe (then under

development). During the study period 1967 through 1969, Monroe was in the final stages of development and it was considered that sufficient data were collected to include Monroe in the analysis.

The counties were separated into two groups for each park. All counties that were closer to the park considered than to any other park were placed in one group (CLOSEST). The other group (INTERVENING) contained all counties that were closer to a park other than the one under consideration.

The decision was made to arrange the data into nine subgroups. The first six subgroups were for a combination of Cagles Mill and Mansfield (three years by CLOSEST and INTERVENING); the last three were for Monroe (three years by one group containing all counties). There are two reasons for isolating Monroe data; firstly, it is apparent from the total attendance figures that Monroe is still in its initial growth period (in contrast to Cagles Mill and Mansfield which are older reservoirs); secondly, Monroe is a much larger reservoir than the other two (10,750 acres compared to Cagles Mill's 1,400 and Mansfield's 2,100), and is, in a sense, unique, since it will remain the largest single body of water in the State for many years. The second reason is essentially the reason for the closest and intervening county groups being combined for Monroe. It is felt that Monroe is such a large trip attractor that intervening opportunities aren't really applicable. Most of the reservoirs planned by the State are more nearly the size of Cagles Mill and Mansfield; therefore, for predictive purposes, a model based on data from these two reservoirs should be more reliable than one which either includes Monroe data, or is based on Monroe data alone.

The data for each of the nine sub-groups were plotted on semi-log graph paper to obtain initial estimates of the parameters of the equations. The non-linear regression program produced nine sets of parameters; these are listed in Table 5. (It should be noted that CLOSEST and INTERVENING refer to two groups of equations derived from a combination of Mansfield and Cagles Mill data only; MONROE refers to a group of equations derived from Monroe data.)

Monroe Model

The idea underlying the following analysis is that if it can be shown that the parameter B_i (for i = 1 to 3) does not vary significantly between the three years, it might be possible to derive a prediction equation (with a pooled estimate of parameter B) by extrapolating the parameter A to the design year.

The first step in the analysis was to test for homogeneity of variances of the trip rate data over the three year period. This assumes that the regression equations were reasonable predictors of the data (which they were). Under these conditions, testing for homogeneity of variances in the data is approximately equivalent to testing for homogeneity of the error estimates of the regression equations. Homogeneity of the error estimates of the regression equations is necessary in order to test the significance of B_i.

Two tests were applied to the data: firstly, Bartlett's Test (22), in which a chi-square statistic is computed (assuming normal populations); and secondly, the Foster-Burr Test (23), in which a Q statistic is computed which is a monotone function of the coefficient of variation of the sample variances. The fact that the populations are not normal

TABLE 5

NON-LINEAR REGRESSION PARAMETERS (TRIP RATES LESS THAN I.O INCLUDED)

YEAR	MONROE		CLOSEST		INTERVENING	
	A	B	A	B	A	B
1967	228	0.606	517	0.571	387	0.715
1968	342	0.530	554	0.736	105	0.354
1969	656	0.588	363	0.523	202	0.548

TABLE 6

NON-LINEAR REGRESSION PARAMETERS (TRIP RATES LESS THAN I.O EXCLUDED)

YEAR	MONROE		CLOSEST		INTERVENING	
	A	B	A	B	A	B
1967	222	0.576	516	0.570	243	0.453
1968	340	0.525	520	0.638	107	0.305
1969	648	0.575	362	0.521	127	0.511

reduces the inferences possible from Bartlett's Test; however, less research has been directed towards non-normal populations than to normal populations, so the test was applied bearing the limitations in mind.

Both Bartlett's Test and the Foster-Burr Test produced statistics for the raw data, Y, and transformed data, Ln (Y + constant), that were highly significant; this led to the rejection of the hypothesis of equal population variances (the constant was added to enable the logarithmic transformation to be made). On the basis of this result, it was decided to delete from the data those counties with trip rates of less than 1.0. It was hoped that homogeneous variances would result from this action. This reduced the sample sizes from 64 for each year to 52, 46, 51 for 1967, 1968, 1969 respectively. The non-linear regression program was rerun with the smaller data sets, and the parameters produced are listed in Table 6. By comparison of this table with Table 5, it can be seen that most of the parameters have been only slightly reduced by excluding trip rates less than 1.0.

Bartlett's Test and the Foster-Burr Test were applied to these data; the chi-square statistic from Bartlett's Test was 0.393, and the Q statistic from the Foster-Burr Test was 0.335, both of which are insignificant at an α-level of 0.01. In this case the hypothesis of homogeneity of variances cannot be rejected.

It was then possible to test the hypothesis that the parameters, B_i, are equal. The procedure, explained in Ostle (24), is to first test the hypothesis that all the observations can be described by one regression equation. If the F-statistic computed is significant (leading to the rejection of the hypothesis), the hypothesis of equal

parameters B_i can be tested by another F-test. F-values of 8.63 and 0.496 respectively were obtained from the two tests; thus, the hypothesis that all the observations can be described by one regression equation is rejected at an α-level of 0.0005, and the hypothesis that the parameters B_i are equal cannot be rejected at an α-level of 0.25.

The pooled estimate of the parameter B for inclusion in the equation for each year was established by running the non-linear regression program for 1967, 1968 and 1969 data combined. The value of B was calculated to be 0.558. As a last step, the non-linear regression program was rerun for each year, forcing a regression line with parameter B = 0.558 through the data, and obtaining the parameter A in the equation

$$Y = A\, e^{-0.558X}$$

The three equations that resulted were:

$$1967: \quad Y = 217\, e^{-0.558X}$$

$$1968: \quad Y = 355\, e^{-0.558X}$$

$$1969: \quad Y = 634\, e^{-0.558X}$$

Figure 5 shows how the parameter A varies from 1967 to 1969. The sharp increase that has occurred is a combination of the growth of Monroe in terms of facilities, reputation and popularity, and of an increase in recreational trip-making, in general. The former is by far the largest component of the growth.

From the above explanation, an extrapolation of the present trend of the parameter A (line A) is likely to overestimate the design year parameter A. What is more likely to happen is a leveling off as

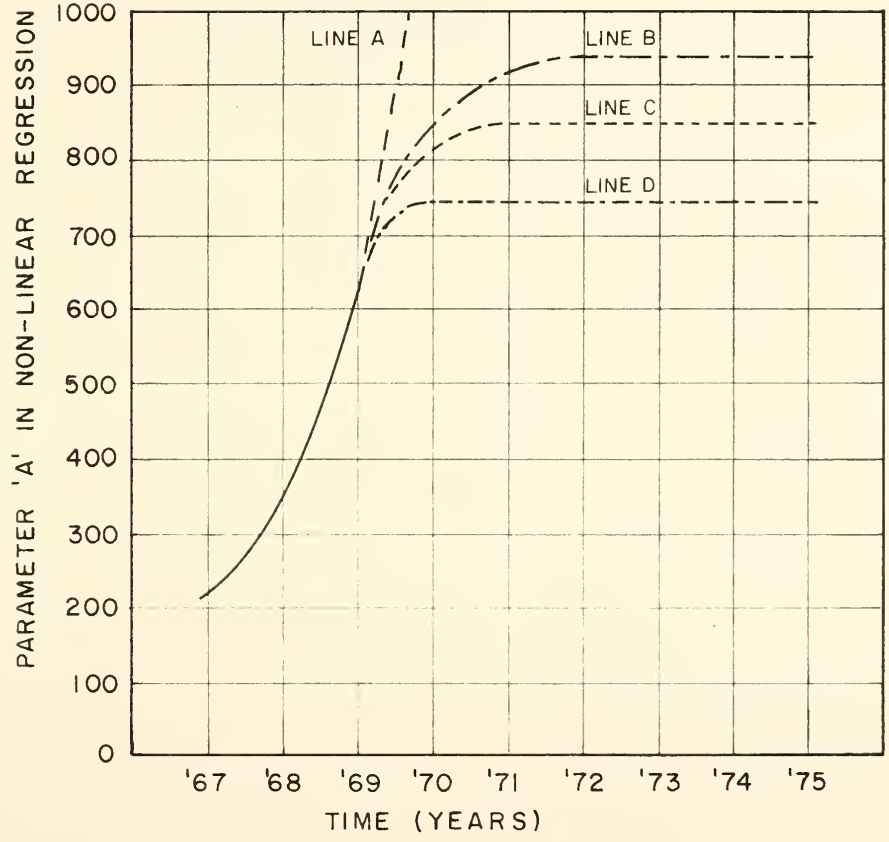

FIGURE 5

MONROE – CHANGE IN PARAMETER "A" WITH TIME

indicated by lines B, C, and D. Without knowledge of other factors, however, there is no basis for choosing any one line over the others. It was therefore decided to use the value of parameter A as obtained from the 1969 data and to acknowledge that it is a conservative estimator of the total annual trips to Monroe for some future year.

The choice of a 1969 equation as the prediction equation was not based on the fact that no significant differences were found between the parameters B_i. The equation adopted as the Monroe Model,

$$Y = 634\ e^{-0.558X}$$

however, does include a contribution from the data of each year (the pooled estimate of B), and so the previous analysis has not been ignored. The Monroe Model is shown in Figure 6.

New Reservoirs Model

The New Reservoirs Model is to consist of two equations (one from each of the CLOSEST and INTERVENING groups of equations) that are considered to be the best for prediction purposes.

Exactly the same procedure that was employed in the development of the Monroe Model was employed to develop the equations for the New Reservoirs Model. The parameters of the three equations for the initial run of the non-linear regression program are shown in Table 5. Once again, the variances of each year's data were not homogeneous until counties with trip rates of less than 1.0 were excluded from the analysis. The program was rerun and the parameters of the three new equations obtained are listed in Table 6. The results from Bartlett's Test and the Foster-Burr Test for these data were such that the hypothesis of equal variances could not be rejected.

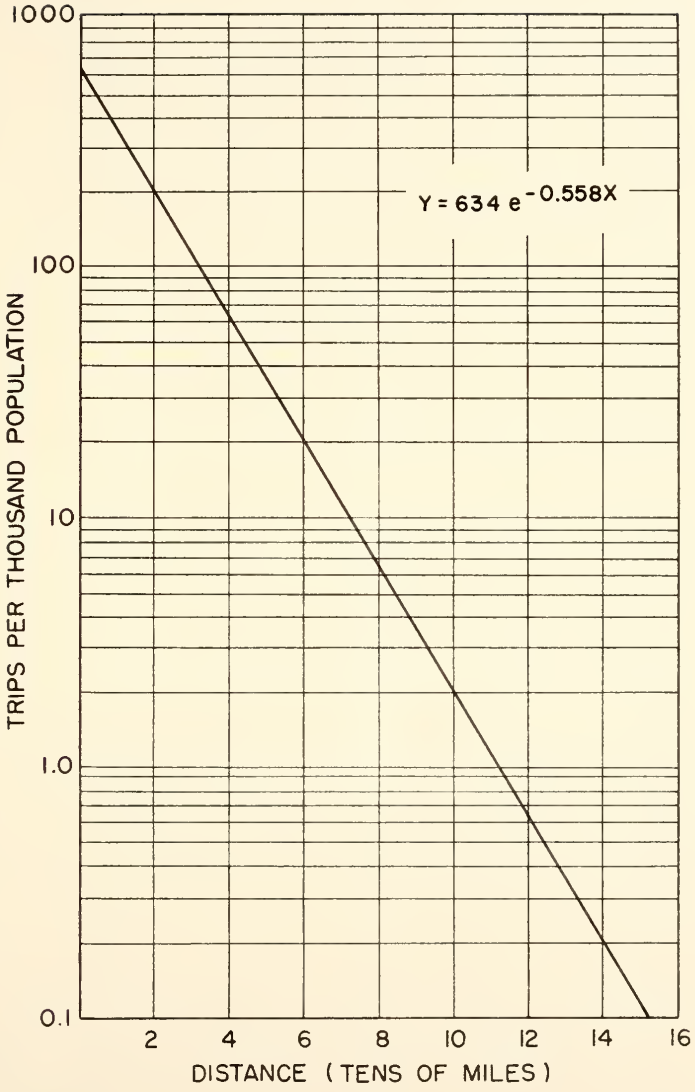

FIGURE 6

ANNUAL TRIPS TO MONROE

The hypothesis of equal parameters B_i for each year for CLOSEST and INTERVENING was tested next, and in both cases it was found that the hypothesis could not be rejected. The data for each year were combined within CLOSEST and INTERVENING, and the non-linear regression program was rerun to find a pooled estimate of parameter B for each group. The pooled estimates of B were 0.573 and 0.407 for CLOSEST and INTERVENING respectively. The result of forcing these B values through the data for each year are the following equations:

CLOSEST	1967:	$Y = 520\ e^{-0.573X}$
	1968:	$Y = 465\ e^{-0.573X}$
	1969:	$Y = 398\ e^{-0.573X}$
INTERVENING	1967:	$Y = 212\ e^{-0.407X}$
	1968:	$Y = 151\ e^{-0.407X}$
	1969:	$Y = 136\ e^{-0.407X}$

It is immediately apparent that the parameter A is decreasing in both cases (while in the case of Monroe, the parameter A was increasing yearly). To understand why this is the case, the location of Mansfield and Cagles Mill with respect to Monroe should be considered. All three reservoirs are within 60 miles of each other; because of this, it would be naive to think that the attendance at Mansfield and Cagles Mill should remain unaffected during the growth period of Monroe. It is considered likely that this downward trend in parameter A is no more than a transient response to the appearance of Monroe, and that it will not continue for more than a few years. For this reason, and for the

fact that the future recreational reservoirs (for which the New Reservoirs Model is intended) will not be close to such a large facility as Monroe, it was decided to use the equations that were developed from 1967 data for CLOSEST and INTERVENING.

The actual equations adopted to constitute the New Reservoirs Model are:

$$\text{CLOSEST:} \quad Y = 520\, e^{-0.573X}$$

$$\text{INTERVENING:} \quad Y = 212\, e^{-0.407X}$$

Note that both these equations, which are shown in Figures 7 and 8, respectively, use the pooled estimate of the parameter B.

Trip-Making Characteristics

Total Annual Trips

It is not enough for the planner to know how many trips (as predicted by the New Reservoirs Model) will be made to a particular reservoir in any year. The additional information that he requires is the distribution of these trips over the year, the week, and the day, so that he can provide for adequate park facilities, the seasonal hiring of park staff, and easy and adequate access. Since the planner is interested in the maximum volumes, it is in terms of these that the following analysis is performed.

Approximately 95 percent of all trips to a reservoir are made between the beginning of April and the end of September. (This is based on information from Phase I, since no out-of-season interviews were performed during Phase II.) The maximum volume week was determined

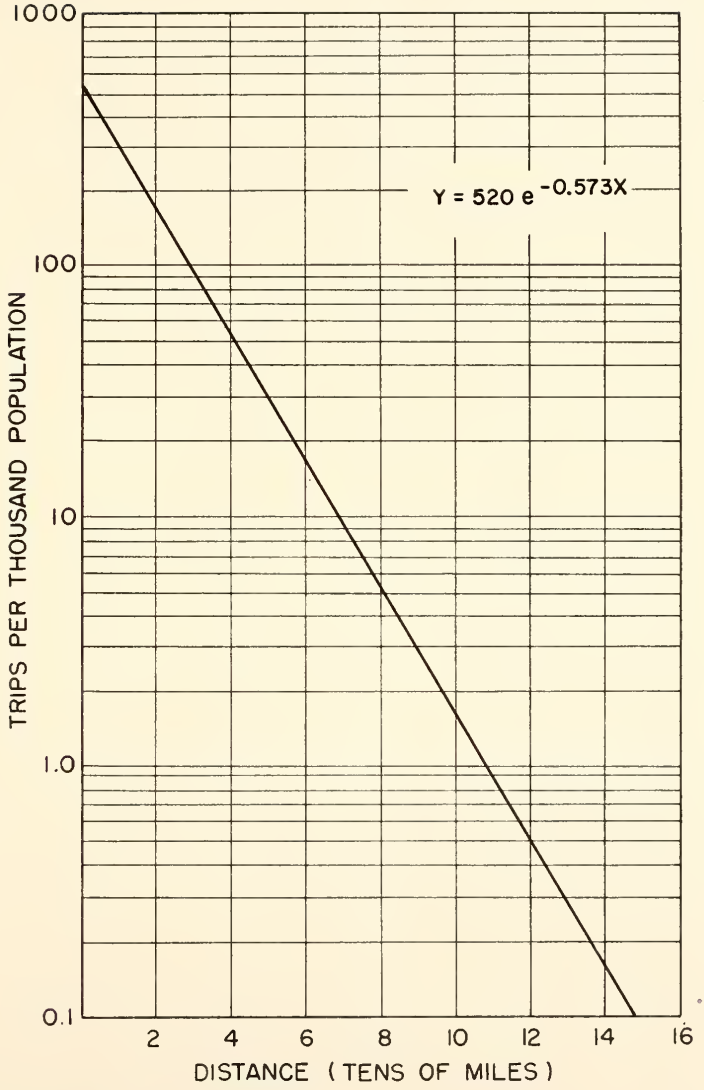

FIGURE 7

ANNUAL TRIPS TO CLOSEST PARK

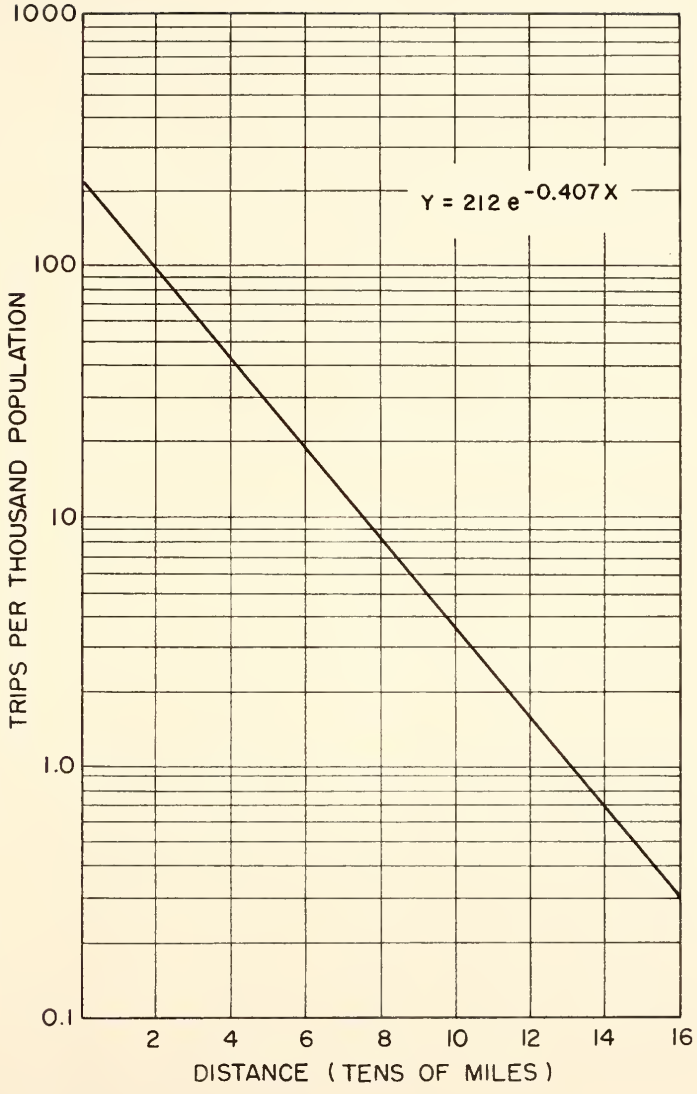

FIGURE 8

ANNUAL TRIPS WITH INTERVENING PARK

for each reservoir for each year from official attendance figures, and the average ratio of maximum volume week to total annual trips was calculated to be approximately 10 percent.

In Phase I (when interviewing was performed on some weekdays) it was found that, on the average, 25 percent of all weekly trips arrived at the reservoir during the period Monday through Friday A.M., assuming similar weather conditions. This means that, on the maximum volume weekend, 75 percent of the 10 percent of the total annual trips to the reservoir can be expected, that is, 7.5 percent.

From data collected in Phase II, it was found (with stable weekend weather conditions) that approximately 50 percent of all weekend trips arrived on Sunday. It is therefore concluded that on the maximum volume weekend, the reservoir attendance will amount to 7.5 percent of the total annual trips, and that the highest daily volume (3.75 percent of the total annual trips) will occur on Sunday.

A further breakdown may be made by looking at the hourly arrivals for each reservoir that were graphed in Phase I. It can be seen that, on the average, 62 percent of all Sunday arrivals come in the four-hour period between 11 a.m. and 3 p.m. Using this information, the capacity required on reservoir access roads may be calculated.

Besides the vehicular trips that can be expected on the maximum volume weekend, it is of importance to know how many people are associated with these trips. During Phase II of this study, it was found that the average number of persons per trip was 3.75, and the average number of children per trip was 1.02.

Correlation Between Road Distance and Travel Time

In Phase I of this research, road mileage was selected to describe the spatial separation between a county and a reservoir in the model. Another descriptor of spatial separation which is used quite frequently in urban transportation studies is travel time. New models using travel times in lieu of road distances were not developed because the major objective of this phase of the research was to observe changes in the previously developed models. Those models were based on travel distances.

In order to justify the use of road mileage in Phase II, road mileage and travel time data were obtained through interviews of 2,500 drivers. The sample correlation coefficient, r, was calculated and found to be equal to 0.92. This suggests that road mileage and travel time are equally good descriptors of spatial separation for recreational travel to reservoirs, and could be used interchangeably in the model (although the parameters of the model would be different in each case). This is not an unexpected result since most of the travel is made on rural highways and county roads. Since the road mileages from each county to each reservoir are easier to obtain (from a State Highway Map) than the corresponding travel times, it is far more appropriate to use road mileage in the model.

Figure 9 shows the percentage cumulative distribution of samples from the interviews. It can be seen that 95 percent of the samples originated within the 125 mile radius adopted for this analysis. The median distance traveled is 52 miles and the associated travel time is 62 minutes. This analysis pertains to 1968 data only.

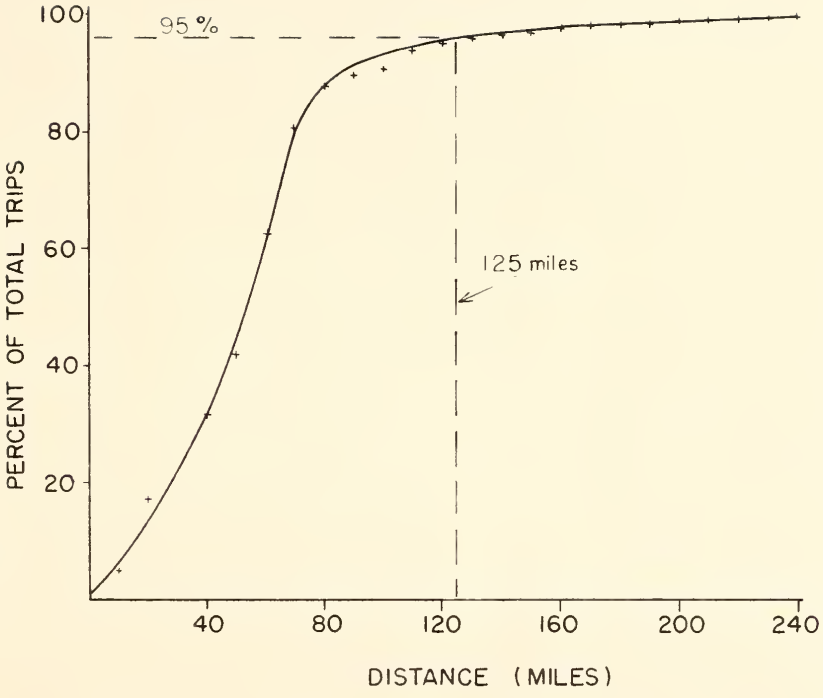

FIGURE 9

CUMULATIVE DISTRIBUTION OF TRIPS, 1968

Effect of Stateline on Out-of-State Trip Rates

As has been mentioned earlier (DATA COLLECTION), it became apparent, when comparing Illinois and Indiana county trip rates, that Illinois county trips rates were lower than those of Indiana counties for any given distance from a park. A stateline penalty was therefore added on to Illinois county distances from the three reservoirs. By observation, this was judged to be 30 miles. This means that Vermilion County, Illinois, whose actual road distance from Mansfield is approximately 60 miles,is assumed for the purposes of this analysis to be 90 miles from Mansfield.

It is reasonable to expect Illinois County trip-rates to be lower, simply because Illinois residents are less exposed to advertizing of Indiana's recreational facilities (such as is found on State Highway Maps) than to advertizing of similar facilities in Illinois. No state-line penalty was included in Matthias' model; it is felt that the New Reservoirs Model developed here is more realistic because of its inclusion.

Motorboat Usage

Gasoline Consumption

The total gasoline consumption in 1968 by motorboats in Indiana was estimated to be approximately 19 million gallons. (See Table 7). This represents 0.8 of one percent of the total taxable gasoline sales in Indiana in 1968 which were 2,300 million gallons.

The distribution of motors by horsepower is shown in Figure 10. The mean gasoline consumption in each horsepower rating category is

TABLE 7

ANNUAL GASOLINE CONSUMPTION BY HORSEPOWER RATING CATEGORY, 1968

HORSEPOWER RATING CATEGORY	NUMBER IN SAMPLE	PERCENT OF TOTAL	ESTIMATE OF TOTAL NUMBER IN CATEGORY	MEAN ANNUAL FUEL (GALS)	TOTAL ANNUAL FUEL (GALS) BY CATEGORY
0.0 TO 4.9	47	14.64	25648	15.27	391,645
5.0 TO 7.4	63	19.63	34391	43.27	1,488,099
7.5 TO 10.0	33	10.28	18010	21.55	388,116
10.1 TO 15.0	10	3.12	5466	45.00	245,970
15.1 TO 25.0	29	9.03	15820	88.77	1,404,341
25.1 TO 40.0	41	12.77	22372	111.92	2,503,874
40.1 TO 60.0	33	10.28	18010	234.57	4,224,606
60.1 TO 100.0	43	13.40	23476	213.59	5,014,239
100.1 AND OVER	22	6.85	12000	256.15	3,073,800
TOTALS	321	100.0			18,734,690

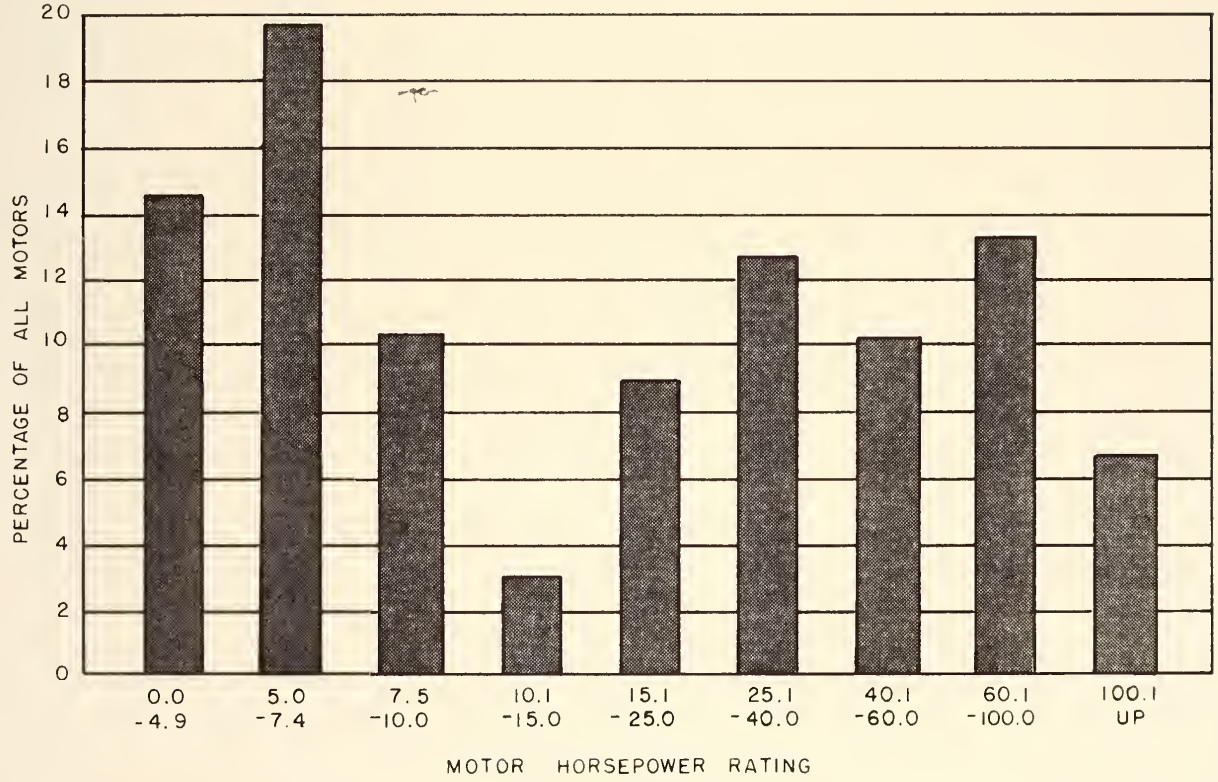

FIGURE 10

DISTRIBUTION OF MOTORS BY HORSEPOWER

shown in Table 8, column 1. These means were calculated from the answers given to Question 7a on the Questionnaire (total amount of gasoline consumed during a previous 12 month period). The product of the answers to Questions 3 and 4 (days out per typical year and gallons per typical day) also gives an estimate of the total amount of gasoline consumed within a year. Mean gasoline consumptions were calculated from these data and are shown in Table 8, column 2.

A two-way analysis of variance test was applied to the two sets of means (25). There was found to be no significant difference between the two sets when $\alpha = 0.05$. The purpose of this test was to determine the internal consistency of the responses to Question 7a and Questions 3 and 4. The analysis indicates that the respondents completed the questionnaire with reasonable care, that the data were probably based upon records or fairly accurate personal estimates. It was decided to use the responses to Question 7a to calculate the total gasoline consumption for 1968, since this question specifically refers to "fuel consumed during a previous 12 month period", not "a typical year" as in Questions 3 and 4.

Mean gasoline consumptions were also calculated from data that were collected from interviews of motorboat owners at Cagles Mill, Mansfield and Monroe Reservoirs during summer 1968. These are tabulated in Table 8, column 3. The same test that was applied to columns 1 and 2 was applied to columns 1 and 3. There was found to be no significant difference between the questionnaire data and the field data. The purpose of this test was to check the validity of the questionnaire responses. The analysis suggests that the sample of motorboat owners

TABLE 8

ANNUAL GASOLINE CONSUMPTION FOR EACH MOTOR HORSEPOWER RATING CATEGORY BY SURVEY METHOD

HORSEPOWER RATING CATEGORY	SURVEY METHOD		
	QUESTIONNAIRE		FIELD
	GASOLINE CONSUMED PREVIOUS 12 MONTHS	PRODUCT OF DAYS/YEAR AND GALLONS/DAY	PRODUCT OF DAYS/YEAR AND GALLONS/DAY
0.0 TO 4.9	15.27	33.70	19.03
5.0 TO 7.4	43.27	82.92	29.62
7.5 TO 10.0	21.55	35.63	50.93
10.1 TO 15.0	45.00	75.50	70.76
15.1 TO 25.0	88.77	125.38	78.53
25.1 TO 40.0	111.92	172.38	130.56
40.1 TO 60.0	234.57	293.01	205.57
60.1 TO 100.0	213.59	273.13	280.89
100.1 AND OVER	256.15	352.08	272.39

that were mailed questionnaires was indeed a representative sample of the total population of motorboat owners in the State of Indiana.

Activities of Boat Owners

It is estimated that the average motorboat owner makes 28.3 boating trips per year, and that he uses his boat 3.7 hours per trip. These figures give an average motorboat usage of 105 hours per year. The way in which motorboat owners spend this time varies from one horsepower rating category to another and is shown in Figure 11. It can be seen that the proportion of time spent on fishing decreases with increase in motor horsepower, while the proportion of time spent on cruising and skiing increases with increase in motor horsepower.

Out-Of-State Motorboat Owners

It was found that almost 7 percent of all motorboat owners interviewed during 1968 at Cagles Mill, Mansfield, and Monroe Reservoirs lived outside of Indiana. Closer examination of the data, however, revealed that approximately 82 percent of all the out-of-state motorboat owners interviewed were encountered at Mansfield alone, 3 and 15 percent being the proportions at Cagles Mill and Monroe respectively.

The high proportion appearing at Mansfield can be explained by this reservoir's close proximity (26 miles) to the Indiana-Illinois Stateline. Cagles Mill and Monroe are 43 and 82 miles respectively from the Stateline. It is very probable that the actual proportion of out-of-state motorboat owners using recreational facilities in Indiana is much less than the 7 percent recorded at the three reservoirs mentioned above.

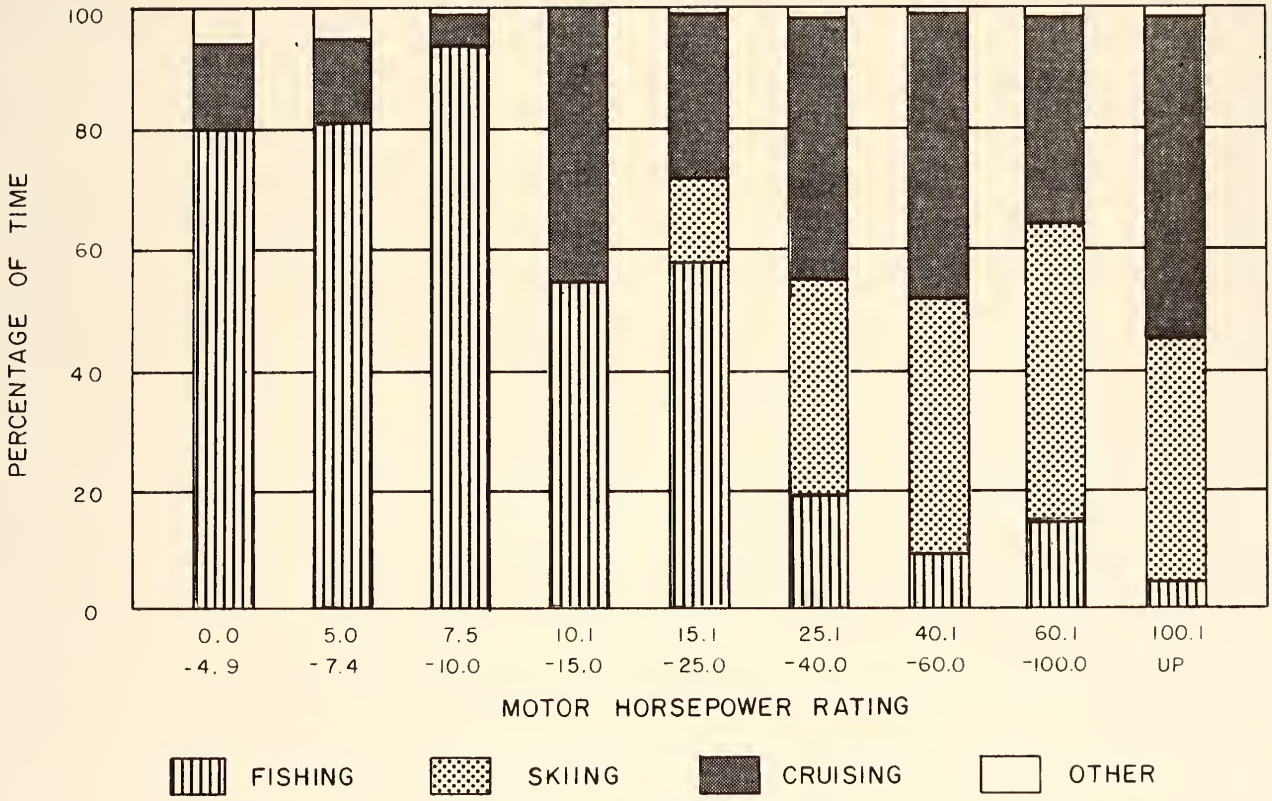

FIGURE II

PERCENTAGE OF TIME SPENT ON MAJOR ACTIVIES BY HORSEPOWER

It is not known how the amount of gasoline purchased in Indiana by these out-of-state motorboat owners affects the estimate of the total gasoline consumption by motorboats in Indiana. The effect can be considered negligible if it is considered plausible that some small portion of the gasoline purchases reported by Indiana motorboat owners were made while visiting recreational facilities in other states.

State Tax Refunds

It is estimated that the State Tax was refunded on approximately 3 percent (equivalent to $37,000) of the total amount of gasoline consumed by motorboats in Indiana. In addition it is estimated that approximately 7 million gallons of gasoline (tax equivalent $420,000) was sold tax-exempt at State-licensed marinas at recreation areas in Indiana in 1968. (There are approximately 100 marinas currently licensed in Indiana.) The combined total from refunds and tax-exempt sales of gasoline is $457,000. This still leaves a total of $680,000 that was unrefunded in calendar year 1968. Expenditure by the Indiana State Highway Commission for maintenance and construction of roadways in state parks and recreational areas amounted to approximately $712,000 for fiscal year July 1, 1968 to June 30, 1969.

APPLICATION OF PREDICTION TECHNIQUE

Total Annual Trip Prediction for Mississinewa Reservoir, 1975

In order that the use of the New Reservoirs Model to predict future trip attractions to a reservoir is fully understood, the procedure involved will be illustrated by a worked example.

Mississinewa Reservoir is located on the Mississinewa River, approximately 10 miles southeast of Peru in Miami County. It has been completed with the last few years, and has recreational facilities similar to those at the reservoirs that were studied, (see Figure 12). 1975 was chosen as the design year for this example.

The first step is to list all counties within 125 road miles of Mississinewa. The second step is to determine which counties are closer to Mississinewa than to any other similar facility, and which are closer to other similar facilities than to Mississinewa. For this example, Salamonie, Huntington, Mansfield, Cagles Mill and Monroe Reservoirs, and Indiana Dunes State Recreation Area, are considered to be similar facilities.

The next step is to estimate the 1975 populations for the counties concerned. The 1975 population projections used in this example are those suggested by the Graduate School of Business of Indiana University (18).

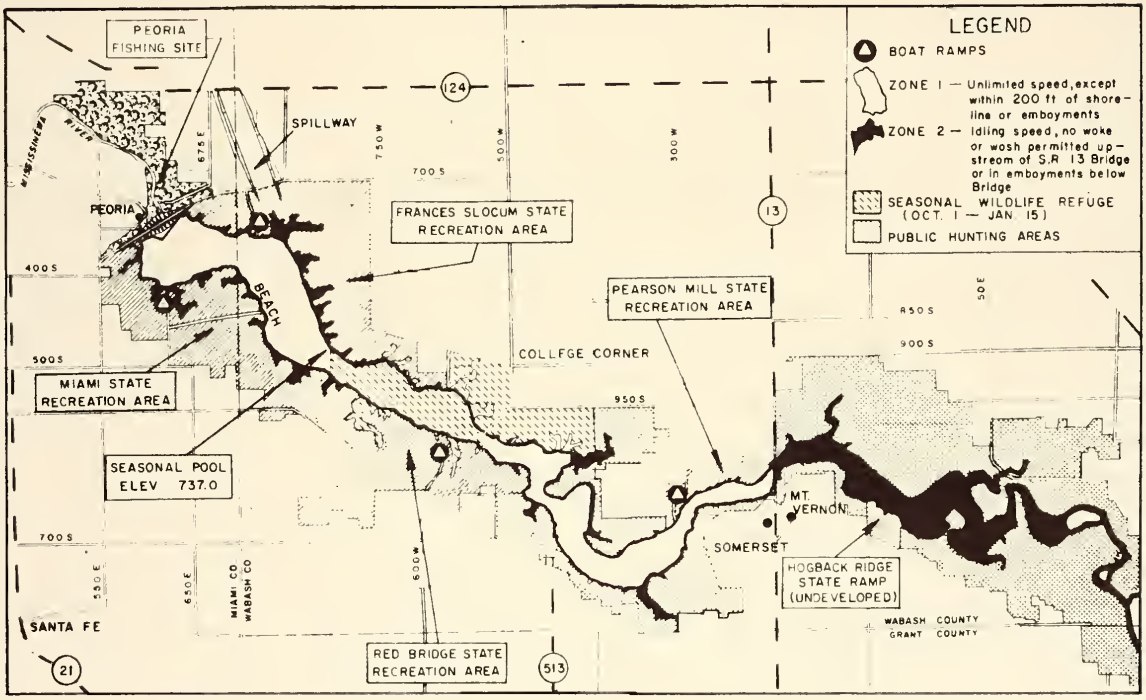
PEORIA FISHING SITE
SPILLWAY
PEORIA
FRANCES SLOCUM STATE RECREATION AREA
BEACH
PEARSON MILL STATE RECREATION AREA
COLLEGE CORNER
MIAMI STATE RECREATION AREA
SEASONAL POOL ELEV 737.0
MT. VERNON
SOMERSET
HOGBACK RIDGE STATE RAMP (UNDEVELOPED)
SANTA FE
RED BRIDGE STATE RECREATION AREA
WABASH COUNTY
GRANT COUNTY
MIAMI CO.
WABASH CO.
LEGEND
BOAT RAMPS
ZONE 1 — Unlimited speed, except within 200 ft of shoreline or embayments
ZONE 2 — Idling speed, no wake or wash permitted upstream of S.R. 13 Bridge or in embayments below Bridge
SEASONAL WILDLIFE REFUGE (OCT. 1 — JAN. 15)
PUBLIC HUNTING AREAS

FIGURE 12

MISSISSINEWA RESERVOIR

The trip rates for each county are found by using Figure 13 for the counties closest to Mississinewa, and Figure 14 for the counties which are closer to other similar facilities than to Mississinewa. These trip rates are multiplied by the county populations (in thousands) to obtain the total annual trips for each closest county (Table 9), and all other counties (Table 10). The results are shown in Table 11. The total annual trips for 1975 as predicted by the equations are 97620. This figure is then divided by the expansion factor 0.90 in order to include in the estimate the 10 percent of trips that originated beyond 125 miles from the reservoir. The result is the estimated annual trips to Mississinewa in 1975, 108,500.

As additional population data are made available (from the 1970 Census), the estimates can be easily adjusted. Road distances can also be modified as improvements are made in the highway network.

The prediction procedure can be summarized in the following manner:

1. Determine the location of the reservoir.
2. Locate other similar recreational facilities.
3. Determine the road distance (miles) to the reservoir from counties within 125 miles.
4. Obtain county population predictions for the design year.
5. Determine which of the counties are closest to the reservoir under study, than to any other similar facility.
6. Determine the trip rates for each county closest to the reservoir from Figure 13.
7. Determine the trip rates for the remaining counties from Figure 14.

8. For each county, calculate the total annual trips by multiplying the trip rate by the population prediction.
9. Sum the total annual trips for all counties. Divide by 0.9 to account for trips originating further than 125 miles away. The final figure is the estimated total trips for the design year.

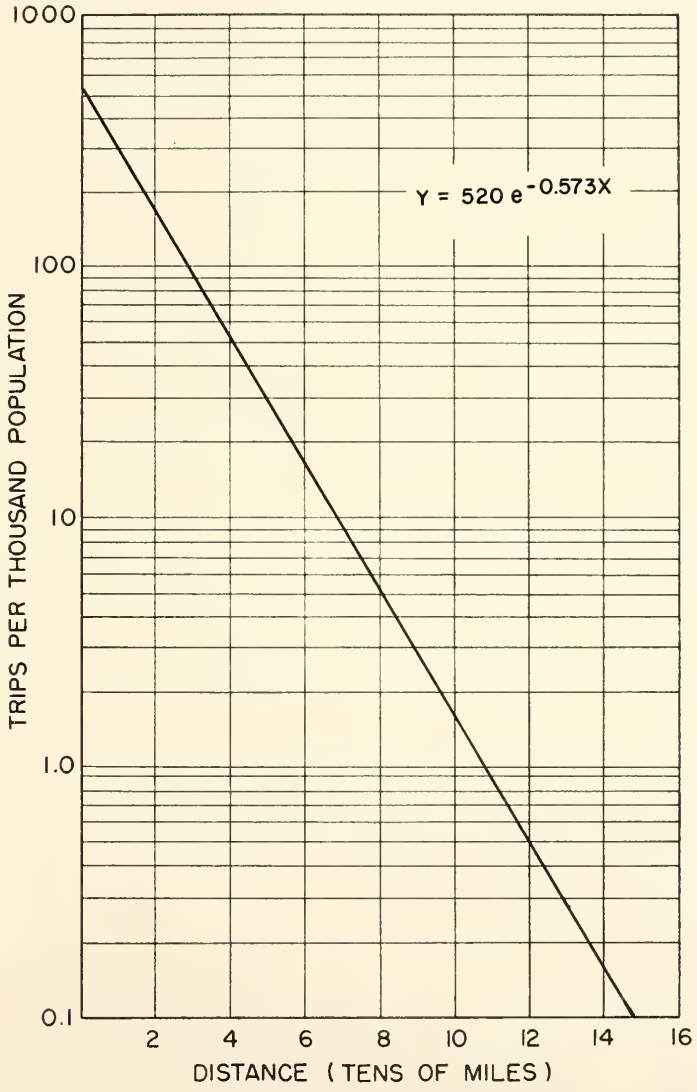

FIGURE 13

NEW RESERVOIRS MODEL:
ANNUAL TRIPS TO CLOSEST PARK

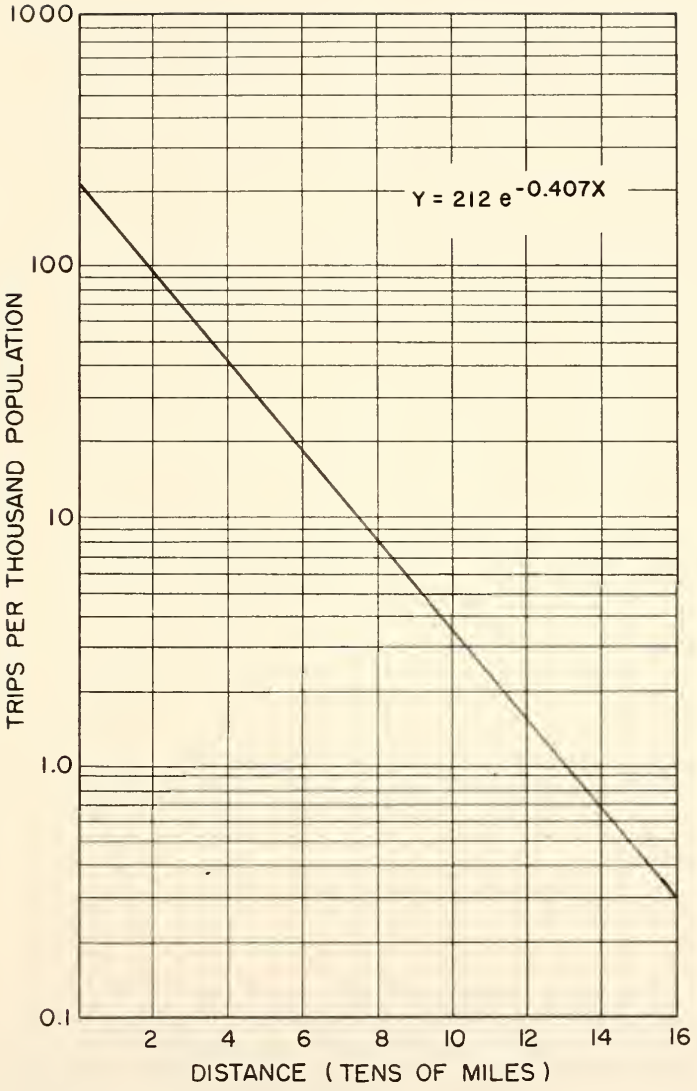

FIGURE 14

NEW RESERVOIRS MODEL:
ANNUAL TRIPS WITH INTERVENING PARK

TABLE 9

MISSISSINEWA, CLOSEST COUNTIES

COUNTY		DISTANCE	POPULATION	TRIP RATE	ANNUAL TRIPS
CODE	NAME	(TENS OF MILES)	(THOUSANDS)	Y	1975
4	BENTON	7.7	12.1	6.31	76
8	CARROLL	4.2	18.0	46.86	843
9	CASS	2.4	42.8	131.45	5627
12	CLINTON	6.3	30.3	14.07	426
20	ELKHART	7.9	99.2	5.62	558
25	FULTON	3.2	17.3	83.12	1434
29	HAMILTON	6.3	58.3	14.07	820
34	HOWARD	2.8	97.9	104.53	10229
43	KOSCIUSKO	4.3	54.5	44.25	2413
48	MADISON	4.4	154.7	41.79	6466
50	MARSHALL	6.9	35.3	9.98	353
52	MIAMI	0.7	47.3	348.18	16476
66	PULASKI	5.2	12.5	26.42	331
80	TIPTON	4.7	15.1	35.19	532
91	WHITE	4.8	21.7	33.23	720
				TOTAL =	47304

TABLE 10

MISSISSINEWA, INTERVENING COUNTIES

COUNTY		DISTANCE	POPULATION	TRIP RATE	ANNUAL TRIPS
CODE	NAME	(TENS OF MILES)	(THOUSANDS)	Y	1975
1	ADAMS	5.3	26.1	24.52	641
2	ALLEN	5.6	317.7	21.62	6869
3	BARTHOLOMEW	12.2	72.5	1.48	107
5	BLACKFORD	5.2	15.3	25.54	391
6	BOONE	7.6	31.9	9.62	307
16	DECATUR	9.9	22.7	3.77	86
17	DEKALB	8.3	31.8	7.23	230
18	DELEWARE	3.9	139.1	43.35	6029
21	FAYETTE	9.7	24.9	4.09	102
23	FOUNTAIN	9.8	19.7	3.93	77
24	FRANKLIN	10.8	18.3	2.61	48
27	GRANT	3.2	100.9	57.63	5815
30	HANCOCK	7.6	39.7	9.62	382
32	HENDRICKS	9.8	77.0	3.93	302
33	HENRY	5.7	52.1	20.34	1086

TABLE 10 , CONTINUED

COUNTY		DISTANCE	POPULATION	TRIP RATE	ANNUAL TRIPS
CODE	NAME	(TENS OF MILES)	(THOUSANDS)	Y	1975
35	HUNTINGTON	3.1	37.7	60.03	2265
37	JASPER	8.6	21.2	6.40	136
38	JAY	7.3	21.1	10.86	230
41	JOHNSON	10.3	82.1	3.20	263
44	LAGRANGE	9.6	20.5	4.26	87
45	LAKE	10.5	648.2	2.95	1915
46	LAPORTE	9.2	117.5	5.01	589
49	MARION	7.8	910.4	8.86	8070
54	MONTGOMERY	9.0	37.4	5.44	205
55	MORGAN	10.7	50.2	2.72	137
56	NEWTON	9.3	11.8	4.81	57
57	NOBLE	7.2	33.1	11.32	375
61	PARKE	12.1	13.0	1.54	20
64	PORTER	9.8	125.0	3.93	491
67	PUTNAM	11.7	27.8	1.81	50

TABLE 10, CONTINUED

COUNTY		DISTANCE	POPULATION	TRIP RATE	ANNUAL TRIPS
CODE	NAME	(TENS OF MILES)	(THOUSANDS)	Y	1975
68	RANDOLPH	6.2	29.0	17.00	493
69	RIPLEY	12.1	23.8	1.54	37
70	RUSH	8.0	20.4	8.17	167
71	ST. JOSEPH	7.8	287.4	8.86	2547
73	SHELBY	9.2	42.2	5.01	212
75	STARKE	6.7	21.0	13.87	292
76	STEUBEN	9.8	17.4	3.93	68
79	TIPPECANOE	6.3	116.4	16.32	1900
81	UNION	10.8	6.3	2.61	16
85	WABASH	1.2	38.2	130.08	4975
86	WARREN	9.4	8.7	4.62	40
89	WAYNE	8.1	79.6	7.85	625
90	WELLS	4.1	23.7	39.96	948
90	WHITLEY	5.0	23.0	27.70	636
				TOTAL =	50316

TABLE II

MISSISSINEWA, 1975 TOTAL TRIPS

	1975 TRIPS
CLOSEST	47304
INTERVENING	50316
TOTAL	97620
DIVIDE BY EXPANSION FACTOR 0.9	108466
PREDICTION (ROUND OFF TO NEAREST 100)	108500

DISCUSSION OF RESULTS

The primary objective of Phase II was to evaluate the growth trends of recreational usage of multi-purpose reservoirs with reference to the model developed in Phase I. The choice of an exponential model, $Y = Ae^{-BX}$, to relate trip rates and distances in Phase I was substantiated by the data collected during Phase II; three equations of this form were developed. Of these three equations, two (developed from data collected at Mansfield and Cagles Mill Reservoirs) constituted the New Reservoirs Model. The third equation (the Monroe Model) is to be used to predict annual trips to Monroe Reservoir only. The main reason for developing a separate model for Monroe was its uniqueness.

The two equations that together constitute the New Reservoirs Model result from the two categories into which all counties within 125 miles of Mansfield and Cagles Mill were divided. The equation that is to be used for counties for which the reservoir under study is the closest reservoir is $Y = 520\ e^{-0.573X}$. The equation for counties for which the reservoir under study is not the closest reservoir (that is, an intervening opportunity exists), is $Y = 212\ e^{-0.407X}$.

These two categories were adopted in Phase I because a model of this form has an intuitive basis and was able to produce accurate trip estimates. This was the primary reason why the analysis was performed in this manner in Phase II. It was also possible to compare models from Phase I and II. The difference between the equations for the two

categories substantiates the assumption that a trip desires to be as short as possible. Given a choice of several reservoirs with similar recreational facilities, people will tend to attend the closest.

The two equations developed in Phase I for the closest and intervening categories were $Y = 338\ e^{-0.479X}$ and $Y = 129\ e^{-0.488}$ respectively. Comparing the equations from Phase I and II, it can be seen that while an increase in the value of the parameter A (by factors of 1.54 and 1.64 for closest and intervening categories respectively) has occurred over time, there has been little change in the value of parameter B (almost none in the case of closest counties). This is an important result, since it implies that a growth in the trip rates (which was being investigated in Phase II) is best measured by changes in the value of parameter A. Furthermore, if continued study indicates even higher trip rates, only the parameter A in each of the two equations need be adjusted. It is not known by how much or in what manner the A parameters of the two equations are likely to change over a period of one or two decades. The data collected in this recreational study rendered any prediction of the future behavior of A unwise; only the fact that A did increase over time was observed.

The single equation that constitutes the Monroe Model is $Y = 634\ e^{-0.558X}$. There is no way of comparing this equation with those of the New Reservoirs Model, because it was developed using all counties within 125 miles of Monroe in the same category. No Monroe data was used in Phase I, so there is no way of making a comparison between the two phases of the study. It should be remembered that this equation is a conservative estimator for the total annual trips to Monroe, since Monroe can still be considered to be in its initial growth period.

It is concluded that the New Reservoirs Model, which is based on easily understood and readily obtainable variables (distance, population and the influence of similar facilities), is able to predict future attendance at new reservoirs with reasonable accuracy. In contrast to previously developed models, which require many socio-economic and park characteristics variables (often difficult to measure and evaluate and extremely difficult to project), the New Reservoirs Model is probably as accurate and much simpler to use. The New Reservoirs Model is adequate for advanced planning purposes and can be used to predict reservoir attendance and traffic volume estimates.

The secondary objective of Phase II was to determine the amount of gasoline consumed by motorboats in the State of Indiana. It is estimated that in 1968, approximately 19 million gallons of gasoline were consumed by motorboats; this figure represents eight tenths of one percent of the total taxable gasoline sales in that year in Indiana. By comparison, previous studies in California in 1964 (15) and Missouri in 1966 (16) have revealed values of six tenths and seven tenths of one percent respectively. The tax paid into the motor vehicle tax fund from sales of gasoline for motorboats in 1968 was estimated to be approximately $680,000; this is less than one half of one percent of the revenue collected by the State from motor vehicle fuel tax.

SUGGESTIONS FOR FURTHER RESEARCH

The procedure used in the selection of the equations for the New Reservoirs Model and the Monroe Model was to assume a constant value for parameter B in the equation $Y = Ae^{-BX}$, and observe the change in parameter A over time. The decision of which value to adopt for parameter A in both models was based on knowledge of the changing local conditions in which the reservoirs under study were operating. It is suggested that further research be carried out to determine more exactly the behavior of the parameter A over time at fully developed reservoirs and at reservoirs under development. Also, it is suggested that the New Reservoirs Model be evaluated when actual 1975 attendance figures for Mississinewa become available.

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APPENDICES

RESERVOIR STUDY

FACILITY: _____ DATE: _____ WEATHER: _____

LOCATION: _____ DAY: _____ COLLECTED BY: _____

TIME	COUNTY OF RESIDENCE	ACTIVITY (SEE CODE)	NUMBER UNDER 12	NUMBER IN CAR	EQUIPMENT HAULED (SEE CODE)	LICENCE NUMBER	REMARKS
1400	MONROE	B	0	4	J	53B 12	
	BARTHOLOMEW	LP	2	5		3B2684	
	MARION	SP	2	7		93A9033	
	VIGO	C	3	6	N	29205Y	TRUCK
1500	CALHOUN, MICH.	CBF	0	2	J	TP5123	VISITING
	MONROE	B	0	2	M	75335M	
	AUGLAIZE, OHIO	CF	0	4	M	887XK	
	MADISON	CF	0	3	MNJ	10959Y	
	DELAWARE	BC	2	6	J	23122Z	
1600	MARION	B	0	4	J	93H9362	
	MONROE	P	0	2		53B1290	
		P	0	2		249 WQ	NEW YORK
	MARION	B	0	3		49P9315	

FIGURE 15

DATA COLLECTION SHEET

TABLE 12

ACTIVITY CODE

ACTIVITY	CODE
BOATING	B
CAMPING	C
FISHING	F
HIKING	H
LOOKING AROUND	L
PICNICKING	P
SWIMMING	S
OTHER (MAKE NOTE)	O

TABLE 13

EQUIPMENT CODE

EQUIPMENT	CODE
BOAT	J
CAMPING TRAILER	K
HOUSE TRAILER	M
CAMPER (BUS, TRUCK, ETC.)	N

APPENDIX B

MOTORBOAT FUEL CONSUMPTION QUESTIONNAIRE

The state of Indiana is continually striving to improve existing recreational areas and develop new facilities.

A study is currently being conducted by Purdue University to help in planning for these recreational areas. One phase of this study concerns motorboat fuel consumption. We are asking a carefully-selected sample of boat owners across the state to complete the enclosed questionnaire to help us with this study.

You are asked not to place your name on this questionnaire as there is no reason to identify any respondent.

A. Our sampling technique includes all boat owners in the state. If you do not own a motor, check here and simply return the questionnaire.

☐ I do not own a motor with my registered boat(s).

B. If you do own a motor please check the appropriate boxes or respond to the questions asked.

1. Is your motorboat (Check One)

☐ an outboard ☐ an inboard-outboard ☐ an inboard

2. Check the appropriate category for the horsepower rating of your motor(s).

First Motor		Second Motor
_____	0.0 - 4.9	_____
_____	5.0 - 7.4	_____
_____	7.5 - 10.0	_____
_____	10.1 - 15.0	_____
_____	15.1 - 25.0	_____
_____	25.1 - 40.0	_____
_____	40.1 - 60.0	_____
_____	60.1 -100.0	_____
_____	100.1 -150.0	_____
_____	150.1 -200.0	_____
_____	200.1 - up	_____

3. In a typical year how many days will you use your boat?

_____ days per year

4. What is the average amount of fuel your boat will use for a typical day of boating?

_____ gallons per day

5. How many hours will your motor be operated during a typical boating day?

_____ hours

6. What percentage of your boating time is spent in each of these categories?

_____ % skiing _____ % cruising

_____ % fishing _____ % other purposes

7a. How many gallons of gasoline did you or other people use in this boat during a previous 12 month period?

_____ gallons

7b. Did you file a claim for a state tax refund on this fuel?

☐ Yes ☐ No

7c. Did you file a claim for a federal tax refund on this fuel?

☐ Yes ☐ No

8. How many miles (round trip) did you ordinarily travel between home and the lake or river you usually used the boat in during a previous 12 month period?

_____ miles (round trip)

Thank you for your kind assistance.